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Bill:

Enclosed are xeroxed copies of the most pertinent parts of RHO-BWI-C-56 (1979). I trust they will give you what you need.

Water Well Siting - Water Rights - Waste Disposal - Mineral Exploration
Engineering Geology

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In most instances, rising water levels with time as more land is irrigated and the creation of more and more drainage problems clearly indicate the importance of irrigation to recharge of the water table or unconfined aquifer. The water available for recharge includes leakage from canals and wasteways, surface runoff from irrigated land, discharge or spillover of excess irrigation water, and seepage to the water table from the irrigated land itself.

Currently, water balances in the irrigated areas have not been determined, except for the Pasco Greenbelt Area. Even there, the pumping rates are not known except for the U.S. Army Corps of Engineer's facilities. In most instances, only the pump rating is available, and the amount of water used and the amount lost at various points can only be estimated. That losses are considerable are recorded in such studies as that of the U.S. Army Corps of Engineers (1978) in the Pasco Greenbelt Area, where the onset of the irrigation season in the West Pasco (Riverview) area is marked by a 3-foot rise in the water table. Groundwater conditions within the study areas listed are discussed individually in the following sections. The reader is referred to the accompanying plates for reference geographic locations, except where other figures have been provided.

THE PASCO GREENBELT AREA

History of the Area

The Pasco gravels are most prominent and abundant in the Pasco Greenbelt Area of the study area. There, the geologic structure, stratigraphy, and impact of the glacial Lake Missoula floods have combined to provide the highest yield aquifers in the study area. An over plentiful supply of imported irrigation water recharges the aquifer and assures a water table high enough for most needs. Pothole Irr. Canal?

Irrigation development via wells and the geologic conditions present have resulted in local over-pumping in some locales, although drainage problems have developed elsewhere. Consequently, more detailed geologic and hydrologic studies have been conducted there than in any other single locale in the Pasco Basin external to the Hanford Site.

Plate 8, the unconfined water-table map, shows the approximate gradient and levels of the water table as determined from recently reported levels, largely new wells. Previous reports (for example, Walters and Grolier, 1960) show water-table levels as they were prior to irrigation recharge.

The magnitude of the change in 20 years is readily apparent. At the lower ends of Smith Canyon and Esquatzel Coulee, levels rose more than 100 feet. This is in spite of pumpage from irrigation wells in both coulees.

Farther down gradient toward the Columbia River, the levels show a progressively lesser rise until, at the Columbia River, levels are as noted in 1959.

The U.S. Army Corps of Engineers, as part of the McNary Dam project, constructed aboveground and underground levees to protect low-lying parts of Pasco and Kennewick from the waters of Lake Wallula. The levees are founded on the impermeable silts and clays of the lowermost part of the Ringold Formation. Free movement of river or groundwaters beneath the levees is precluded.

Collection ditches behind the levees collect groundwaters draining toward the Columbia River and divert them to pumping stations. There, they are lifted into the Columbia River. Automatic controls maintain levels of 330 to 332 feet altitude at the pumping stations. This is the pre-McNary Dam level of the river and water table there.

In the Pasco area, one pump station lies at Road 56 and the levee (332 feet altitude); the other at the continuation of Illinois Street and the levee (Northwest 1/4, Section 31, Township 9 North, Range 30 East). Over the years, the pumping rate at the Illinois Street station has steadily increased and is now more than double its original rate. The rate at Road 56 is nearly unchanged. The change in pumping rates reflects increasing drainage from the South Columbia Basin Irrigation District, but the lack of change at Road 56 reflects geologic barriers that divert the increased drainage away from the Road 56 station and toward the Illinois Street station. Consequently, groundwaters unable to escape to the river via their normal paths were diverted into unnatural courses and effectively ponded. By 1969, increasing irrigation runoff combined with increased pumpage into the area by the Franklin County Irrigation District resulted in the water table surfacing at Road 52 and Pearl Street. For several years, the water table rose at an annual rate of 6 inches a year.

The Walla Walla District of the U.S. Army Corps of Engineers, responsible for lands immediately adjoining Lake Wallula, constructed a pumping station at Road 52 and Pearl Street to dewater the area. A drain line was installed beneath Road 52 into the Columbia River. Pumps with a capacity of 6,000 gallons per minute began operating. The water table at the pump site was lowered about 6 feet, but only a few inches at 1,000 feet away. The data confirmed that the locale lay on the south side of a very highly permeable area.

The groundwater problem was compounded by construction of a pumping station by the Franklin County Irrigation District between the Road 56 station and the Road 52 outfall. Its purpose was to better pressurize the irrigation lines. Accurate records of the pumping rate at that station or the station at the west center of Section 18, Township 9 North, Range 29 East that feeds into the canal system are not known.

The U.S. Bureau of Reclamation, under pressure to reduce the impact of runoff from the South Columbia Basin Irrigation District, constructed a pumping station at the junction of Selph Landing Road and Glade North Road (mouth of Esquatzel Coulee). Water that was threatening to reach the Tri-Cities Airport via surface channels was pumped into the Esquatzel Wasteway and discharged into the Columbia River. The effect of the pumping station was noted at the Illinois Street pumping station.

Ultimately, the pumping stations and extensive irrigation from wells in the Pasco Greenbelt Area resulted in falling water levels and decreasing yields of some wells. This resulted in the U.S. Army Corps of Engineers' study (1978).

Geology of the Area and Transmissivity Values

The geology of the Pasco area, centering on the greenbelt, was determined using all available well logs. Many wells had been tested for specific capacity; those specific capacity numbers then were converted to transmissivity values using the equation:

$$T = Q/s\ (1{,}700)$$

where T is transmissivity in gallons per day per foot, Q is quantity of water pumped, and s is the drawdown at that pumping rate (Theis, 1954; Bierschenk, 1959). The resulting T values are, of course, approximations that are subject to variation depending on size of the well, accuracy of measurement of pumping rate, accuracy of measurement of drawndown, efficiency of the well, and whether equilibrium was achieved. They are intended to provide relative value.

The transmissivity values were determined from about 100 wells (see Appendix) where specific capacity tests had been run. This is an average of about one value per square mile. Plotting of contours (Plate 9) clearly reflected the effect of geology there; hence, provided quality assurance of the validity of the concepts determined.

A very low-yield zone (less than 10,000 gallons per day per foot) borders and evidently underlies the Columbia River, at least from west Pasco and probably west Kennewick across from Burbank. It reflects the presence, near the water table, of the low-permeability silts and clays of the lower part of the Ringold Formation. South of the axis of the Pasco syncline, those sediments rise steadily toward the Horse Heaven Hills at a greater rate than the water table, effectively thinning the aquifer. Beyond the Snake River where the silts and clays are eroded, the underlying basalts are progressively closer to, then in, the river bed causing the aquifer to thin and pinch out downstream.

The yields are consistently higher northward from Pasco reflecting the effect of the Pasco syncline and the downfolding of the silts and clays appreciably below the water table. Beyond Selph Landing Road, the silts and clays, and ultimately the basalts, rise sufficiently high to thin and finally to terminate the unconfined aquifer.

The geology, as confirmed by the transmissivity values, clearly shows why drainage problems have developed in west Pasco and why the pumping stations have proved inadequate in dewatering the area.

The highest yield wells, producing 3,000 or more gallons per minute, lie in a rectilinear pattern formed by zones trending north-northeast and west-northwest. Those zones are, respectively, the sub-surface continuations of Esquatzel Coulee and Smith Canyon and an ancestral Columbia River channel, all evidently cut during the glacial Lake Missoula floods. Those channels, now filled with highly permeable Pasco gravels, are the principal high-yield aquifers of the Pasco Greenbelt Area. Elsewhere, where such channels do not exist, such as west of Road 68, the permeability and transmissivity values are typical of the Ringold Formation conglomerate, and yields of wells are on the order of a few hundreds of gallons per minute.

West of Esquatzel Coulee, the water-table aquifer continues northward, where the westward-dipping basalts lie adequately below the water table. Very few wells are present and yields are low to very low (a few tens of gallons per minute). Most wells penetrate into and produce at least some water from the basalts. Specific capacity data for these wells are sparse and the accuracy of the data, especially for the unconfined aquifer, is low. Moreover, most of the wells are 20 or more years old and neither the current water-table level nor the effect of irrigation runoff and perched water tables are known.

The water-table gradient and very high-transmissivity zones trending south-southwest from Smith Canyon and Esquatzel Coulee confirm that most waters in the Pasco Greenbelt Area are derived (recharged) from those coulees. The water, upon entering the low-transmissivity zones near the Columbia River, are diverted east-southeastward either along the highly permeable zone immediately north of Pasco, or for waters at Road 52 and Pearl Street (the U.S. Army Corps of Engineers' pumping station) through the sediments of lower permeability toward the lift station on the projection of Illinois Street.

The West Pasco (Riverview) area is likened to a bathtub with the north side breached and a high south rim. Water can freely enter the "tub," but can escape with difficulty only by rising over the high south rim that has few breaches in it and by flowing through lower permeability sediments to the lift station.

Significantly, the lift station at Road 56 is ineffective because of the low-permeability sediments between it and the U.S. Army Corps of Engineers' pumping station at Road 52 and Pearl Street. Small amounts of water reach the lift station from the north, but most waters are derived from the west via collection ditches. Farther downstream, beyond the underground levees, groundwaters are free to flow into the Columbia River west and northeast of Sacajawea Park and no drainage problems exist there.

The transmissivity values calculated from the specific capacity data were used as the basis of the model study of the area. Following the model study, the station at Road 52 and Pearl Street was shut down and surface water in Esquatzel Coulee was diverted into Smith Canyon. The plan then relied upon pumping from irrigation wells to protect the West Pasco (Riverview) area, and used excess water to recharge the aquifer in Smith Canyon where levels had fallen. In late 1979, water levels were below the land surface level in the low areas in West Pasco (Riverview), about as predicted by the U.S. Army Corps of Engineers' model study (1978). Recharge of Smith Canyon was inadequately effective, probably because of a too-low flow, a too-short recharge time, and possibly channeling of the water away from the areas needing recharge.

The Pasco area study demonstrated that relatively complex and detailed geology can be identified from water well logs. In addition, usable transmissivity values can be determined from the specific capacity tests. The values then can help explain the geology and, in turn, be explained by the geology.

THE BURBANK-WALLULA AREA

Subsequent to the Pasco area study for the U.S. Army Corps of Engineers, a smaller but similar study was conducted for them in the Burbank area. The purpose was to determine if sites existed in which yields of wells could meet or exceed 1,000 gallons per minute. Test drilling had failed to disclose any locales. No computer modeling was planned.

The available logs of wells were examined in the same manner as for the Pasco area. A geologic map and transmissivity map were constructed, coordinating the geology and the transmissivity values. Plates 5 and 9 contain updated versions of those earlier maps.

More than 100 wells are recorded from Burbank to Wallula Junction. This is an average of more than two wells per square mile into or through the unconfined aquifer. Yields of wells commonly are a few tens of gallons per minute.

Only one limited zone was found in which high yields are possible. It is a northwest-trending zone that appears to be the continuation of a similar zone in the Pasco area (see Plate 9). A review of well logs indicated the presence of a scoured channel in the Ringold Formation surface that was filled with Pasco gravels. The data and conclusions agreed with the general findings of the more experienced drillers who have worked in the area. Plans for a proposed project were dropped.

Expansion of the Boise Cascade plant at Wallula called for a water supply increase by 5,000 gallons per minute desirably from groundwater sources. Following the drilling of several test wells that yielded about 300 gallons per minute each confirmed Ringold Formation conglomerates.

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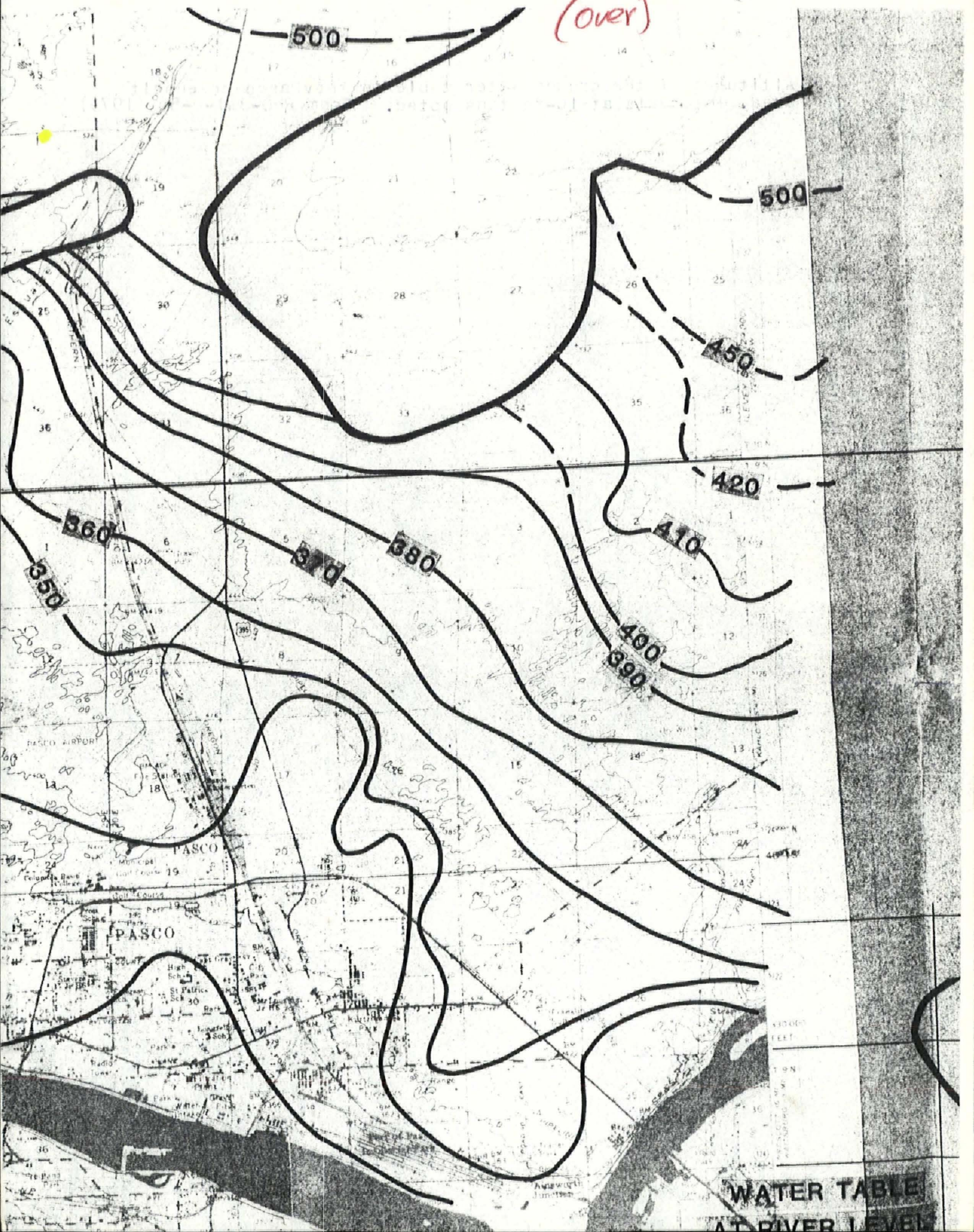
(Plate 8?)

(over)


500
500
450
420
410
400
390
380
370
360
350
PASCO
PASCO
PASCO AIRPORT
WATER TABLE

Altitudes of the ground water table in the Pasco greenbelt area. Intervals at 10-feet as noted. From RHO-BWI-C-56 (1979)

(over)


10,000
50,000
100,000
500,000
100,000
50,000
50,000
50,000
10,000
100,000
500,000
2,000,000
50,000
100,000
800,000
600,000
200,000
PASCO
KENNEWICK
Burbank

Transmissivity values in the Pasco greenbelt area, with values in gpd/ft, as noted. From RE Brown, RHO-BWI-C-56 1979.